Embedded Linux Development Kit for VIPER Single Board Computer

Quickstart Manual

Arcom

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Revision History

Manual	*PCB*	*Date*	*Comments*
Issue A		23rd June 2003	First release of manual.
Issue B		3rd February 2004	Update for V315 Development Kit.
Issue C		19th August 2004	New layout, major modifications.
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Issue E		22nd November 2005	Minor amendments.

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Contents

Introduction

The VIPER is an ultra low power PC/104-compatible single board computer based on the Intel 400MHz PXA255 XScale processor. The PXA255 is an implementation of the Intel XScale micro-architecture combined with a comprehensive set of integrated peripherals including:

- Flat panel graphics controller.
- Interrupt controller.
- Real Time Clock (RTC).
- Multiple serial ports.

The VIPER board offers many features that make it ideal for power-sensitive embedded communications and multimedia applications.

Handling your board safely

Anti-static handling

The SBC and other circuit boards fitted inside the VIPER ICE contain CMOS devices. These could be damaged in the event of static electricity being discharged through them. Please observe anti-static precautions at all times when handling circuit boards. This includes storing boards in appropriate anti-static packaging and wearing a wrist strap when handling them.

Packaging

Should a board need to be returned to Arcom, please ensure that it is adequately packed, preferably in the original packing material.

Environmental

The VIPER ICE enclosure is fitted with the VIPER-UPS. The battery fitted to the VIPER-UPS is a 7-cell battery pack containing Varta V500 HRT NiMH (Nickel Metal Hydride) cells. These cells contain 0% lead, 0% mercury and 0% cadmium.

About this manual

This manual gets you started using the VIPER with RedBoot and Arcom Embedded Linux (AEL). It lists the items you should find in your kit, and tells you how to unpack, connect and configure the board.

This manual also covers the CYCLOPS product. The CYCLOPS is pre-installed with the same Linux software as the AEL Development kit. All AEL-specific documentation also applies to the CYCLOPS system.

Related documents

This Quickstart Manual is supplied as part of the VIPER RedBoot and AEL Development Kit. Other manuals that you may need are provided on the CD-ROM that accompanies your Development Kit. These include the VIPER Technical Manual and the AEL Technical Manual.

Detailed information about AEL is provided in the AEL Technical Manual. This manual includes information about the following:

- Configuration files and boot scripts.
- Making an application run automatically at boot.
- AEL contents.
- Installation.
- Utilities.
- Secure Shell (SSH).
- Compiling a kernel.

Conventions

Symbols

The following symbols are used in this guide:

Symbol	Explanation
📌	Note - information that requires your attention.
💡	Tip - a handy hint that may provide a useful alternative or save time.
	Caution - proceeding with a course of action may damage your equipment or result in loss of data.

Typographical conventions

This manual contains examples of commands that you can enter. These are shown as follows:

$ **make install DESTDIR=/tmp/target-install**

The initial symbol ($ in this case) indicates the prompt that the command is for, and should not be typed.

The prompts used are explained in the following table:

Prompt	Explanation
$	Linux (bash shell) as a regular user.
#	Linux (bash shell) as root.
RedBoot>	RedBoot command line.

Different fonts are used throughout the manual to identify different types of information, as follows:

Font	Explanation
Italics	Parts of a command that should be substituted with appropriate values.
Bold	Information that you enter yourself.
`Screen text`	Information that is displayed on screen.

Getting started

What’s in the kit?

The VIPER RedBoot and AEL Development Kits contain the VIPER Industrial Compact Enclosure (ICE), which includes:

- VIPER-400-M64-F32.
- UPS power supply.
- CompactFlash IEEE802.11b WiFi Card.
- Flat panel display 5.5" NEC (optional).
- Touchscreen and touchscreen controller (optional).

The CYCLOPS Development Kit contains the CYCLOPS Enclosure, which includes:

- VIPER-400-M64-F32.
- Flat panel display 8.4" NEC.
- Touchscreen and touchscreen controller.

All Development Kits contain:

- +24V @ 2.5A max (85-264 VAC input) power supply.
- US, UK or EURO power supply cable.
- Crossover RJ45 Ethernet cable.
- Null modem cable.
- This Quickstart Manual.

In addition, the AEL and CYCLOPS Development Kits include the following:

- AEL support and installation CD.
- Fedora Core installation media[1].
- AEL Technical Manual (on CD).

[1] fedora.redhat.com

What else do I need?

An x86 Linux system compliant with version 1.3 of the Linux Standard Base[2] is required for the Arcom Embedded Linux host environment. Suitable systems include PCs with Debian GNU/Linux, RedHat Linux, Fedora Core or SUSE Linux.

In addition, the following information may be useful:

- Networking details for the VIPER. If your network does not have a DHCP server, ask your network or system administrator for the following:

  - IP address and subnet mask (netmask).

  - Default gateway IP address (if required).

  - Name server (DNS) IP address (optional).

- Networking details for the host machine.

[2] http://www.linuxbase.org/

What peripherals are supported?

Linux supports the following peripherals in this release:

- 5 UARTs, COM1 through COM5, including the processor’s internal FFUART, BTUART and STUART.
- On-board Flash array.
- CompactFlash+.
- Ethernet interface.
- Audio.
- A variety of flat panels, including the supplied flat panel running at 320 x 240 (optional).
- Touchscreen.
- Power management.
- GPIO.
- Real time clock.
- SRAM.
- USB host controller.
- PC/104 bus. Drivers are available for a range of Arcom and third party PC/104 boards.

Unpacking and connecting up

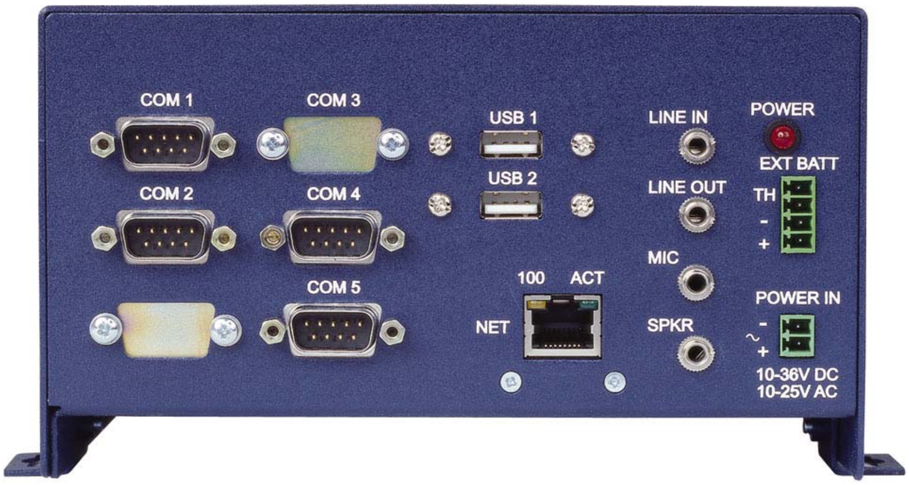
This section guides you, step-by-step, through the process of connecting up the VIPER for the first time and powering up the system. The VIPER is delivered ready to run. There are no link settings or configuration switches that need to be adjusted for the board to operate.

A number of the components are static-sensitive, so standard anti-static precautions must be taken during use. For more information, see Anti-static handling, page 4.

If you follow the procedure described below, the board powers up automatically and loads the RedBoot boot loader from the on-board Flash array. If you have the AEL Development Kit, it continues to load automatically and boots AEL.

To power up the VIPER and boot AEL, follow these steps:

1 Remove the VIPER ICE (Industrial Compact Enclosure) or CYCLOPS from its packaging. If it shows any signs of damage during transit, please contact Arcom before proceeding.



VIPER ICE

2 Fit the VIPER power supply interface cable to the socket on the enclosure and to the power supply adapter.

3 Fit the AC input cable.

4 Connect a serial terminal emulator[3] to COM1 using the supplied null modem cable.

[3] Such as Minicom running on a Linux PC or Hyper Terminal on a Windows PC.

5 Configure the serial terminal as follows:

- 115200 baud.
- No parity.
- 8 data bits.
- No handshaking.

6 Switch on the VIPER board once the terminal emulator is set up on the host PC.

What happens next depends on whether you have a basic RedBoot Development Kit, an AEL Development Kit or a CYCLOPS:

- If you have a RedBoot Development Kit, you are dropped to the RedBoot command prompt, where you can upload and execute your application. For more information see page 13 and the AEL Technical Manual, which is in the /manuals/ folder on the Development Kit CD.

-or-

- If you have an AEL Development Kit or CYCLOPS, the Linux operating system is loaded from the on-board Flash array, and the board displays a Linux prompt.

  For a description of AEL see page 15 and the AEL Technical Manual, which is in the /manuals/ folder on the Development Kit CD.

Power supply

The AC Power Supply Unit (PSU) supplied in the kit is rated at 2.5A @ +24V DC. This is designed to support the requirements of the VIPER ICE or CYCLOPS. If additional devices are powered from this supply, ensure that the overall current rating is not exceeded.

In a VIPER ICE system, the UPS signal /POWER_DOWN is connected to /OUT0 on pin 13 of PL9 of the VIPER. This means the UPS can be shut down using GPIO20.

RedBoot

What is RedBoot?

RedBoot is a complete bootstrap environment for embedded systems. Based on the eCos Hardware Abstraction Layer, RedBoot inherits the eCos qualities of reliability, compactness, configurability, and portability.

RedBoot enables download and execution of embedded applications via serial or Ethernet, including embedded Linux and eCos applications. It can be used for both product development (debug support) and in deployed products in the field (Flash update and network booting).

Ethernet download and debug support is included. This means RedBoot can retrieve its IP parameters via BOOTP or DHCP, and program images can be downloaded using TFTP or HTTP. Images can also be downloaded over serial (using X- or Y-modem) or loaded from a JFFS2 file system on the on-board Flash.

An interactive command-line interface is accessible via serial or Ethernet and allows management of Flash images, image download, RedBoot configuration, etc. For unattended or automated startup, boot scripts can be stored in Flash. This allows, for example, loading of images from Flash or a TFTP server.

You cannot use the command-line interface via Ethernet if you have an automatic boot script enabled which launches an application or another operating system, since RedBoot does not stop to listen for TCP/IP activity.

The Arcom Embedded Linux (AEL) Technical Manual contains details of many of the RedBoot commands that are useful when using RedBoot as a boot loader for another operating system (such as Linux) or to launch an application. Full RedBoot documentation is available in the eCos Reference Manual, which is in the /manuals/ folder on the Development Kit CD.

Default boot script:

If you have purchased an AEL Development Kit, the default boot script on the VIPER is configured to load a Linux kernel from the JFFS2 filesystem and execute it:

```
clock –l 27 –m 4 –n 10
mount -t jffs2 -f filesystem
load -r -b %{FREEMEMLO} %{kernel}
exec -c %{cmdline}
```

`%{FREEMEMLO}` is a predefined alias for the lowest address of available memory.

`%{kernel}` is an alias for the full path name of the Linux kernel to boot.

`%{cmdline}` is an alias for the kernel command line to use.

Refer to the AEL Technical Manual for further details.

CPU Core Clock Frequency and the clock command

Versions of RedBoot on the VIPER up to and including V3I3 initialized the CPU clock to 200MHz at boot time. For version V3I4 this was changed to boot at 400MHz. The current version (V3I5) no longer changes the clock rate, so it remains at the default 100MHz setting. However, this version introduces an additional command (**clock**), which can be used to set the clock to any of the frequencies described in the CPU clock frequency scaling section on page 22. The **clock** command takes parameters for the L, M and N settings which control the clock speed as described in that section. The value of N should be 10 times the actual value. Therefore, to set N to 1.5, pass the option **–n 15**. For example:

- To set the clock frequency to 300MHz power saving mode:

  RedBoot> **clock –l 27 –m 1 –n 30**

- To set the clock frequency to 200MHz performance mode:

  RedBoot> **clock –l 27 –m 2 –n 10**

If you have an AEL Development Kit, the default AEL boot script initializes the clock to 400MHz.

Arcom Embedded Linux (AEL)

What’s in AEL?

AEL is a space-optimized Linux distribution based on Linux kernel version 2.6. AEL includes many of the standard file, shell and text utilities. As well as the basic Linux system, the default installation includes:

- OpenSSH Secure Shell.
- Minimal X Window System.
- Web server.

For a complete list of software and an explanation of how to add and remove packages please consult the AEL Technical Manual, which is on the accompanying CD.

Booting the system

Once the system has been connected and powered up (as described in Unpacking and connecting up, page 10) the board automatically boots to a Linux prompt, as follows:

```
Uncompressing Linux................. done, booting the kernel.
...
CPU: XScale-PXA255 [69052d06] revision 6 (ARMv5TE)
...
Machine: Arcom VIPER SBC
Memory policy: ECC disabled, Data cache writeback
Memory clock: 99.53MHz (*27)
Run Mode clock: 398.13MHz (*4)
Turbo Mode clock: 398.13MHz (*1.0, active)
Built 1 zonelists
Kernel command line: root=/dev/mtdblock2 rootfstype=jffs2 ro
console=ttyS0,115200
...
3 RedBoot partitions found on MTD device flash
Creating 3 MTD partitions on "flash":
0x00000000-0x0001f000 : "FIS directory"
0x0001f000-0x00020000 : "RedBoot config"
0x00020000-0x02000000 : "filesystem"
...
INIT: version 2.85 booting
...
Configuring network interfaces...
```

If you do not have a DHCP server and you have not configured a static IP address, the board pauses at this point while it searches for a DHCP server. See Setting up networking, page 18.

```
... done.
...
INIT: Entering runlevel: 3
Starting system log daemon: syslogd.
Starting hotplug subsystem:.... already started. process pending
events.
Starting kernel log daemon: klogd.
Starting NFS common utilities: statd.
Loading /etc/console/keymap.gz
Starting PCMCIA services: done.
Starting internet superserver: inetd.
Starting http server: thttpd.
Starting OpenBSD Secure Shell Server: sshd.
Starting periodic command scheduler: cron.
Arcom Embedded Linux (ttyS0)
viper login:
```

Logging in

You may login to the VIPER as root (the superuser or administrator) using the following details:

Login name:	**root**
Default password:	**arcom**

Setting up networking

As supplied, the board uses the DHCP protocol to configure the network. This requires a DHCP server to be available on your network. For more information, please consult your network administrator.

To configure the VIPER to use a static IP address, follow these steps:

1 Log in to the VIPER by entering the following log in details:

- Login name: **root**
- Password: **arcom**

2 Edit the file /etc/network/interfaces using the nano editor:

```
# nano /etc/network/interfaces
```

3 Modify the **iface eth0 inet dhcp** line to look like the following (substituting your own IP **address** and **netmask**):

```
iface eth0 inet static
    address 10.7.28.2
    netmask 255.255.0.0
    gateway 10.7.1.1
```

4 Save the file by holding down **Ctrl** and pressing **O**.

5 Exit by holding down **Ctrl** and pressing **X**.

6 Optional. Set up a Domain Name System (DNS) server if required. You need a DNS server if you want to use domain names (such as www.arcom.com) when accessing the Internet.

To set up a DNS server, edit the file /etc/resolv.conf and add your DNS server address as follows:

```
nameserver 10.7.1.9
```

7 Reinitialize the networking by typing:

```
# /etc/init.d/networking restart
```

The following is displayed:

```
Reconfiguring network interfaces...done
```

Chapters 25 and 26 of the RUTE Manual provide a useful introduction to TCP/IP networking. This manual is on the Development Kit CD, in the /manuals/ folder.

The file system

The file system used on the VIPER Flash memory is a compressed Journaling Flash File System (JFFS2). JFFS2 has the following advantages:

- Robustness.
- Power fail safe.
- No integrity scan (fsck) is required at boot time.
- Flash wear levelling.
- Transparent compression, with a typical compression ratio of 2:1.

The on-board Flash is partitioned using RedBoot FIS, as shown in the following table:

Partition #	Block device	Size (KB)	Offset (KB)	Description
0	/dev/mtdblock0	124	0	Partition table
1	/dev/mtdblock1	4	124	RedBoot configuration
2	/dev/mtdblock2	remainder	128	Root file system

Previous versions of Arcom Embedded Linux on the VIPER made use of a separate kernel partition. From version 4 issue 1 onwards, the kernel is stored as a regular file in the /boot/ folder on the root filesystem.

In addition, a 4MB RAM-based file system is mounted on /var/tmp for temporary files. These are lost on reboot.

The basic AEL install uses about 7.9MB of physical Flash. On a board with 32MB of Flash memory fitted, this leaves about 24.1MB free. This is about 50MB of free space, assuming a typical 2:1 compression ratio. You can make additional space available by removing unused packages. For more information, refer to the AEL Technical Manual, which is in the /manuals/ folder on the Development Kit CD.

The default Flash image is on the Development Kit CD, in the /images/ folder. For an explanation of how to reload a complete Flash image, see the AEL Technical Manual.

Linux kernel

The version of the Linux kernel used on the VIPER is a standard Linux 2.6 kernel tree with patches to provide support for Arcom's boards.

Source and configuration

The kernel sources are installed in the host environment as /opt/arcom/src/linux-source-VERSION.tar.gz.

Once you have unpacked the kernel source you can configure the default VIPER kernel with:

```
$ make ARCH=arm viper_defconfig
```

The kernel may now be built and installed as described in the AEL Technical Manual.

Default command line

The default kernel command line is:

```
root=/dev/mtdblock2 rootfstype=jffs2 ro console=ttyS0,115200
```

Hardware configuration

Touchscreen Controller (TSC1)

If your VIPER ICE was supplied with a touchscreen, the touchscreen controller is attached to /dev/ttyS2 (COM3). In a CYCLOPS system, the touchscreen controller is attached to /dev/ttyS4 (COM5).

PC/104 bus

The PC/104 bus on the VIPER is attached via the second PCMCIA controller built in to the PXA255 processor.

The PC/104 I/O address space is mapped at virtual address 0xF1000000. This means that a PC/104 card that has been configured at I/O address 0xXXX is available at virtual address 0xF1000XXX. This virtual address is the correct value to use when configuring a device driver for that card, rather than the associated physical address.

Previous versions of Arcom Embedded Linux on the VIPER using version 2.4 of the Linux kernel used 0xF7000000 as the offset for the PC/104 I/O address space.

The PC/104 memory address space is available at physical address 0x3C000000. This means that a PC/104 card that has been configured for memory address 0xXXXX is available at physical address 0x3C00XXXX. It is the responsibility of the driver to map this address into the kernel's virtual address space before use.

The PC/104 interrupts are mapped as shown in the following table:

PC/104 interrupt	VIPER interrupt
3	104
4	105
5	106
6	107
7	108
10	109
11	110
12	111
9*	112
14*	113
15*	114

* These interrupts are only available on version 2 of the VIPER hardware.

For more information, see the VIPER Technical Manual and PXA255 Developer's Manual.

CPU clock frequency scaling

The PXA255 processor used on the VIPER can scale the core clock frequency from 100 to 400MHz, allowing an application to dynamically trade off performance against power consumption. The functionality is exposed in Linux via special files in the /sys system. These can be manipulated directly (e.g. using **cat** and **echo**), but are better controlled using the **cpufreq-info** and **cpufreq-set** utilities. Both utilities are described below.

The processor's clock and power manager, including the available Core Clock Control Register (CCCR) multiplier configurations, are described in detail in the PXA255 Processor Developer's Manual, which is in the /references/ folder on the Development Kit CD. The CCCR consists of 3 multipliers - L, M and N:

- The L multiplier converts the basic 3.6864MHz crystal frequency into the memory clock frequency. Typical values of L are 27, 36, and 45.
- The M multiplier converts the memory clock frequency into the run-mode frequency. Typical values of M are 1, 2 and 4.
- The N multiplier converts the run-mode frequency into the turbo-mode frequency. Typical values of N are 1.0, 1.5, 2.0 and 3.0.

Not all combinations of L, M and N are valid. Some valid combinations are described below, and more information is available in the PXA255 Processor Developer's Manual.

The Linux kernel divides the available clock configurations into two complementary sets of available frequencies, corresponding to the run-mode and turbo-mode multipliers. The first set is the 'performance' set. These use the run-mode multiplier (CCCR[M]) to scale the clock frequency. Increasing the run-mode multiplier in this way gives the best performance but at the cost of increased power consumption.

The second set of frequencies are the 'powersave' frequencies. These use the turbo-mode multiplier (CCCR[N]) to scale the clock frequency. This uses less power than the run-mode multiplier but with a performance cost (especially if frequent memory accesses are required), since the core must wait for these while running in turbo mode.

The Linux kernel manages the current clock configuration using a software governor combined with user-specified minimum and maximum desired clock frequencies.

In the default VIPER kernel three governors are provided:

- The 'performance' governor selects the maximum allowed frequency from the processor's available performance frequencies.
- The 'powersave' governor selects the lowest available frequency from the available powersave frequencies.
- The 'userspace' governor allows direct userspace selection of a frequency from the available performance frequencies.

The default is to use the performance governor with a maximum frequency of 400MHz. The powersave and userspace governors are supplied as loadable kernel modules, called cpufreq_powersave and cpufreq_userspace respectively. They may be loaded using the **modprobe** command.

The available performance clock rates are listed in the following table. They correspond to the modes available when the turbo mode multiplier, CCCR[N] is 1.0.

Clock speed (KHz)	Core Clock Configuration Register (L, M and N multipliers)	Memory clock (MHz)	Run clock (MHz)	Turbo clock (MHz)	PX bus (MHz)
99532	27, 1, 1.0	99	99	99	50
132710	36, 1, 1.0	133	133	133	66
199065	27, 2, 1.0	99	199	199	99
265421*	36, 2, 1.0	133	265	265	133
331776*	45, 2, 1.0	166	332	332	166
398131*	27, 4, 1.0	99	398	398	196

* Not available on 200MHz VIPER-LITE.

The available powersave clock rates are listed in the following table:

Clock speed (KHz)	Core Clock Configuration Register (L, M and N multipliers)	Memory clock (MHz)	Run clock (MHz)	Turbo clock (MHz)	PX bus (MHz)
99532	27, 1, 1.00	99	99	99	50
199065	27, 1, 2.00	99	99	199	50
298598*	27, 1, 3.00	99	99	299	50
398131*	27, 2, 2.00	99	199	398	99

* Not available on 200MHz VIPER-LITE.

The **cpufreq-set** utility can be used to select a governor and to set the minimum and maximum allowable frequency. This is illustrated by the following examples:

- To select the performance governor and limit the maximum allowed speed to 200MHz:

  ```
  # cpufreq-set --governor performance --max 199065
  ```

- To select the powersave governor and set the minimum allowed frequency to 300MHz:

  ```
  # modprobe cpufreq_powersave
  # cpufreq-set –governor powersave --min 298598
  ```

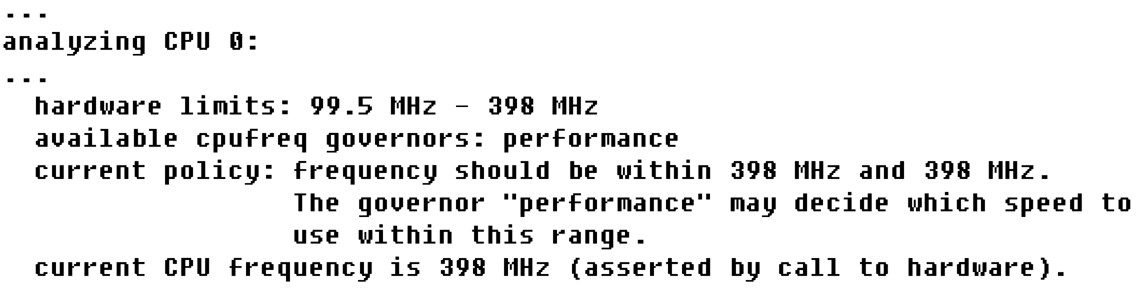
- To use the userspace governor and set a frequency of 400MHz:

  ```
  # modprobe cpufreq_userspace
  # cpufreq-set --governor userspace --freq 398131
  ```

Changing the clock frequency automatically regulates the core voltage in order to maximize power savings.

The current settings can be examined using the **cpufreq-info** utility:

```
# cpufreq-info
```



```
...
analyzing CPU 0:
...
  hardware limits: 99.5 MHz - 398 MHz
  available cpufreq governors: performance
  current policy: frequency should be within 398 MHz and 398 MHz.
                  The governor "performance" may decide which speed to
                  use within this range.
  current CPU frequency is 398 MHz (asserted by call to hardware).
```

Sleep and wake up support

The PXA255 processor supports a low power sleep mode in which the processor shuts down entirely until some external or internal stimulus causes it to wake up. This stimulus can be either an alarm generated by the processor’s internal Real Time Clock (RTC) or a change in the state of one of the processor’s GPIO lines. For an explanation of how to configure the wake up source and ensure that power consumption is reduced to the minimum, see the VIPER Technical Manual.

Once a wake up source has been configured, the processor can be put into sleep mode by writing to the special file /sys/power/state.

The following command, for example, would not appear to return until after the processor has been woken up:

```
# echo –n “mem” > /sys/power/state
```

If you intend to use the PXA255's internal RTC as a wake up source, you must unload the driver for the external RTC (which cannot perform the wake up function) and load the driver for the internal RTC, as follows:

1 Remove the external DS1307 RTC driver:

```
# rmmod ds1307
```

2 Install the SA1100/PXA255 RTC driver:

```
# modprobe sa1100-rtc
```

3 Resynchronize the SA1100/PXA255 RTC to the correct time from the system clock:

```
# hwclock –systohc
```

The source for the arcom-utils package (which is on the Development Kit CD, in the /packages/arcom-utils folder) contains the script **viper-sleep.sh**, which is an example of how to put a VIPER board to sleep and wake it up again.

LCD controller

The LCD controller driver module (pxafb) is configured by default for the 320x240 TFT display (part number NL3224BC35), which is an optional part of the VIPER ICE box. The CYCLOPS image is configured to support the CYCLOPS flat panel (see page 29).

The driver module can be loaded using the normal **modprobe** command:

```
# modprobe pxafb
```

In order to use other LCD modules, extra parameters must be passed to the modprobe command, either on the command line or using one of the methods described in the AEL Technical Manual. The options are given as a comma separated list of parameters. Where a parameter requires a value, it is separated from the parameter name using a colon. The available parameters are listed in the following table. The registers referred to are described in section 7.6.4 of the PXA255 Processor Developer's Manual, which is in the /references/ folder on the Development Kit CD.

Parameter	Description	Default
mode	The required video mode written as: **XRESxYRES-BPP** Where **XRES** is the X axis resolution, **YRES** is the Y axis resolution and **BPP** is the desired bit depth. The hardware supports bit depths of 1, 2, 4, 8 and 16-bits. The LCD driver is known to work well in 8- or 16-bit mode. This parameter corresponds to the LCCR1[PPL], LCCR2[LPP] and LCCR3[BPP] registers.	mode:320x240-16

Continued…

Parameter	Description	Default
pixclock	The pixel clock, expressed in picoseconds (10^{-12}s). This value is used in conjunction with the current memory clock rate to calculate LCCR3[PCD].	pixclock:157500
left, right, hsynclen, upper, lower and vsynclen	The timing parameters. All parameters are given as a number of pixel clock ticks. The upper and lower margins should be 0 for passive (STN) displays. The values correspond to LCCR as follows: • left corresponds to LCCR1[BLW] + 1. • right corresponds to LCCR1[ELW] + 1. • hsynclen corresponds to LCCR1[HSW] + 1. • upper corresponds to LCCR2[BFW]. • lower corresponds to LCCR2[EFR]. • vsynclen corresponds to LCCR2[VSW] + 1. Several of these values are modified by + 1 because the hardware expects the desired value – 1 to be programmed. The values given to this parameter therefore correspond to the desired value rather than the value programmed into the hardware.	left:7, right:13, hsynclen:63, upper:1, lower:1, vsynclen:20.
color or mono	Configures the LCD controller for color or monochrome panels. These parameters correspond to the LCCR0[CMS] register.	color
active or passive	Configures the LCD controller for active (TFT) or passive (STN) displays. These parameters correspond to the LCCR0[PAS] register.	active
single or dual	In passive mode configures the LCD controller for either single or dual panel displays. These parameters correspond to the LCCR0[SDS] register.	N/A
4pix or 8pix	In monochrome passive mode configures the LCD controller for either 4 or 8 pixel mode. These parameters correspond to the LCCR0[DPD] register.	N/A

Continued…

Parameter	Description	Default
hsync and vsync	Configures the polarity of the horizontal and vertical sync pulses. A value of 0 indicates an active low sync pulse, while 1 indicates active high. These parameters correspond to the LCCR3[HSP] and LCCR3[VSP] registers.	hsync:0,vsync:0
outputen	Configures the polarity of the output enable signal. A value of 0 indicates an active low signal while 1 indicates active high. This parameter corresponds to the LCCR3[OEP] register.	outputen:1
pixclockpol	Configures the polarity of the pixel clock signal. A value of 0 indicates a falling edge while 1 indicates rising edge. This parameter corresponds to the LCCR3[PCP] register.	pixclockpol:0

The required values for all of the above parameters are generally defined in the datasheet for a given LCD panel. Often the timing parameters (pixel clock, margins, sync pulse lengths) can be derived from values in the datasheet along with a certain amount of trial and error. It is recommended that you read chapter 7 of the PXA255 Processor Developers manual since many of the parameters given to the driver correspond directly to settings in the LCD controller hardware.

The default parameters are set to support a TFT type panel, so it is therefore possible to support another TFT panel by passing only the **mode** and **timings** parameters. For example, to support a 640 x 480 panel such as the NL6448AC20 you would use the following command:

```
# modprobe pxafb options=mode:640x480-
16,pixclock:39722,left:16,right:81,upper:12,lower:31,hsynclen:63,vsynclen:2
```

The options string must be a single line with no spaces or line-breaks.

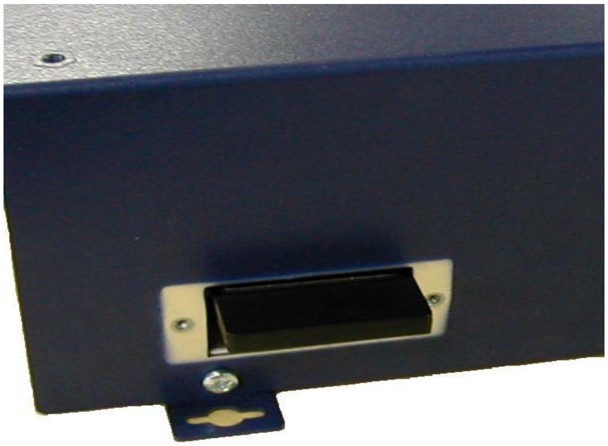
There is much greater variation between STN type panels, so it is necessary to pass all parameters. For example, to support a Kyocera KCS057QV1AA-G00 320x240 single panel color STN display you would use the following command:

```
# modprobe pxafb options=mode:320x240-
8,pixclock:154000,left:1,right:1,upper:0,lower:0,hsynclen:8,vsynclen:32,passive,c
olor,single,outputen:1,pixclockpol:0,hsync:1,vsync:1
```

The options string must be a single line with no spaces or line-breaks.

CompactFlash IEEE802.11b WiFi Card

To install the CompactFlash card remove the retaining screws from the access panel and insert the card as shown:



Note that the card goes in upside down.

Software configuration of WiFi cards is covered in the Arcom Embedded Linux Technical Manual which is on the development kit CD in the /manuals/ folder.

Software configuration

The CYCLOPS and VIPER-LITE systems require some additional configuration. For example you must specify flat panel driver parameters to support the panel supplied with the CYCLOPS. If using the VIPER-LITE, you must inform the Linux kernel of the reduced CPU speed.

The configuration required for each of these systems is described in the following sections.

CYCLOPS software configuration

The CYCLOPS system is shipped with an AEL image that has been configured for the CYCLOPS hardware. The image is available in the /images/ folder on the Development Kit CD.

If you reinstall this image, you will need to recalibrate the touchscreen using the following command:

```
# killall tsc1d
# tsc1cal --device /dev/ttyS4 --generate /etc/tsc1d.conf --ten-bit
```

The touchscreen controller software is described more fully in the AEL technical manual.

The CYCLOPS image also contains a configuration file /etc/modprobe.d/cyclops, which sets up the correct parameters for the flat panel driver and a script /etc/init.d/cyclops which configures COM5 correctly for use with the touchscreen controller. These files are provided by the package variant-cyclops.

VIPER-LITE software configuration

The VIPER-LITE is a reduced power VIPER derivative based around the 200MHz PXA255 processor.

As it is based on the 200MHz part, it is necessary to inform the Linux kernel of the reduced maximum CPU speed. This can be done by adding the following to the default kernel command line:

```
"cpu_pxa.max_frequency=199065"
```

For more information, see Default command line on page 20.

This will limit the available CPU frequencies to 200MHz. For a discussion of CPU clock frequency scaling, see page 22.

The VIPER-LITE Flash image available in the /images/ folder on the Development Kit CD already contains the modified kernel command line.

Support software

Target support software

When building applications for the VIPER board, you must use the AEL host environment. This consists of a set of utilities that provide a cross-compile environment targeting the VIPER board. A cross-compile environment is required in order to produce binaries for the XScale processor.

For an explanation of how to install the host environment, refer to the AEL Technical Manual, on the accompanying CD. This CD also includes example source code for utilizing the Arcom-specific device drivers and utility programs.

Intel Integrated Performance Primitives (IPPs)

Intel supplies a set of code modules optimized for the XScale processor. These provide basic functionality, including:

- Signal, image, speech and audio processing.
- Vector manipulation.
- Matrix math.

Further modules providing primitives useful in specific application areas are available. These application areas include:

- Audio, video and speech codecs, for example MP3 (MPEG-1 Audio Layer 3), MPEG-4, H263, JPEG, GSM-AMR and G723.1.
- Cryptography, for example DES, Triple DES, SHA1 and RSA.

For more information about Intel IPPs, see developer.intel.com/design/pca/application4sprocessors/swsup/IPPv30.htm.

Real-time Linux on the VIPER

Linux was not designed with hard real-time capabilities in mind. It usually meets the needs of soft real-time applications. However, under certain circumstances the scheduling and other latencies do not meet the needs of hard real-time control and communication applications.

For this reason, Finite State Machine Laboratories (FSMLabs, Inc) developed RTLinuxPro. This is a tested and validated, hard real-time, POSIX operating system that runs Embedded Linux as an application platform. Within RTLinuxPro, the standard Linux kernel runs as a low priority task on top of a hard real-time RTOS, RTCore. This means that RTLinuxPro can meet hard real-time deadlines, while offering the power of Linux for less performance-critical aspects of applications.

The VIPER Development Kit CD contains an RTLinuxPro demonstration binary for evaluation purposes. The demonstration consists of an RTLinuxPro-enabled kernel from FSMLabs, and a RAM disk image containing a simple application to measure the interrupt and scheduling latency (jitter).

The jitter test measures the total time delta from the point when the interrupt is generated to the point when the interruption actually happens (i.e. the interrupt latency). It also measures scheduler entry to decide who needs to run, and includes a context switch to get the required task in and running so it can sample the clock.

Obtaining RTLinuxPro

The VIPER Development Kit includes an evaluation version of RTLinuxPro for the PXA255-based VIPER. This is for demonstration purposes only, and cannot be used or shipped in an end product. The Development Kit CD does not contain RTLinuxPro development tools or licensed products.

If you want to develop real-time applications using RTLinuxPro, contact FSMLabs directly at sales@fsmlabs.com.

Source for the parts of the RTLinux demonstration that are licensed under the GPL is available on request under section 3(b) of the GPL.

Performance

To indicate the level of performance achieved using RTLinuxPro, Arcom prepared a test application to exercise the Ethernet port with a ping flood and repeatedly write two large files to the JFFS2 flash drive. Essentially, this represents a ‘busy’ foreground task running under Linux. The jitter test was run with Arcom’s standard Linux and then repeated using RTLinuxPro. The test was performed on a standard VIPER board running with a 400MHz CPU clock speed.

The worst-case jitter measurements running on a 400MHz PXA255 VIPER are shown in the following table:

Linux variant	Maximum jitter
AEL	231ms
FSMLabs RTLinuxPro	50.8µs

Evaluating RTLinuxPro

The VIPER is *not* installed with RTLinuxPro as standard. The RTLinuxPro kernel and RAM-based file system images are provided on the Development Kit CD in the folder /images/rtlinux-demo. They can be booted using the following procedure. Doing so does not affect the standard AEL image, which is stored in the Flash drive. To run the test you must boot RTLinuxPro and then load the test application. To do this, follow these steps:

1. Drop to the RedBoot command prompt. You do this by holding down **Ctrl** and pressing **C** during the early stages of boot.

2. Enter the following commands:

```
RedBoot> load -r -b 0x800000 initrd.gz
RedBoot> load -r -b 0x400000 zImage.viper
RedBoot> exec -r 0x800000 -s 0x1000000 -c "console=ttyS0,115200
root=/dev/ram0"
```

   The RTLinuxPro system boots and drops to a shell log in.

3. Mount the flash and copy multiple files repeatedly in and out of the file system:

```
# mount /dev/mtdblock3 /mnt
# while :; do cp /lib/libc-2.2.5.so /mnt/tmp/x; rm /mnt/tmp/x; done &
[1] 1722
# while :; do cp /lib/libc-2.2.5.so /mnt/tmp/y; rm /mnt/tmp/y; done &
[2] 1723
```

4. Set the CPU speed to either 200MHz or 400MHz as follows:
   - To set it to 200MHz enter:

     ```
     # echo 200000 > /proc/sys/cpu/0/speed
     ```

   - To set it to 400MHz enter:

     ```
     # echo 400000 > /proc/sys/cpu/0/speed
     ```

5. Do one of the following:
   - For the Linux test, run:

     ```
     # /bin/jitter.user
     ```

   - For RTLinuxPro, you must start the underlying RTOS first. Run the following commands by entering:

     ```
     # /bin/rtcore &
     ```

     Allow a short delay for the RTOS to load and configure itself, then enter:

     ```
     # /bin/jitter.rtl
     ```

6. Run a ping flood of the board from another machine:

   ```
   # ping -f viper.ip
   ```

   Worst-case figures are displayed for each test. These are all that matter in hard real-time systems.

Arcom provides support for RTLinuxPro through FSMLabs directly. Contact FSMLabs (at support@fsmlabs.com) if you have questions, or if you require more information about the capabilities of and development tools for RTLinuxPro.

Appendix - Contacting Arcom

Arcom sales

Arcom's sales team is always available to assist you in choosing the board that best meets your requirements. Contact your local sales office or hotline.

Sales office US

Arcom
7500W 161st Street
Overland Park
Kansas
66085
USA

Tel: 913 549 1000
Fax: 913 549 1002

E-mail: us-sales@arcom.com

Sales office UK

Arcom
Clifton Road
Cambridge
CB1 7EA
UK

Tel: 01223 411 200
Fax: 01223 410 457
E-mail: sales@arcom.co.uk

Comprehensive information about our products is available from our web sites: www.arcom.com and www.arcom.co.uk.

While Arcom's sales team can assist you in making your decision, the final choice of boards or systems is solely and wholly the responsibility of the buyer. Arcom's entire liability in respect of the boards or systems is as set out in Arcom's standard terms and conditions of sale. If you intend to write your own low level software, you can start with the source code on the disk supplied. This is example code only to illustrate use on Arcom's products. It has not been commercially tested. No warranty is made in respect of this code and Arcom shall incur no liability whatsoever or howsoever arising from any use made of the code.

Technical support

Arcom has a team of technical support engineers available to provide a quick *and free* response to your technical queries.

Technical support US

Tel: 913 549 1010

Fax: 913 549 1001

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Technical support UK

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